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POTATO FLEA-BEETLE.

(Epitrix cucumeris).

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BULLETIN No. 211.

POTATO FLEA-BEETLE*.

O. A. JOHANNSEN.

THE FLEA BEETLE AND EARLY BLIGHT.

The flea beetle (*Epitrix cucumeris*) is, next to the Colorado potato beetle, the most destructive of the annually recurrent insects on the foliage of the potato in Maine. The insect eats minute holes in the leaf giving it a dotted appearance like a pepper box cover (Fig. 19). Sometimes the damage done by this pest is very marked as was the case of a small unsprayed field in Orono the past year when the plants were entirely killed before July 10. But the danger to the plant is not restricted to what the insect alone can do, for it is generally acknowledged that early blight attacks injured leaves more readily than healthy ones and the punctures made by the insect serve as points of entrance for the germ tubes of the spores of the fungus. The insects themselves are also in all probability active agents in spreading the disease by carrying the spores from plant to plant on their bodies. Early blight is widespread and now very destructive in that it attacks and weakens the plant at a critical period, thus checking the development of the tubers. It is confined to the foliage and is not known to cause rot. Early blight first appears as small brown spots, frequently surrounding flea beetle punctures, scattered over the older leaves. These spots slowly enlarge and frequently become somewhat angular in shape from the fact that they stop on reaching a leaf vein. There is usually a sharp boundary between the healthy green of the leaf and the spot, although a badly spotted leaf will have a decidedly yellow appearance over its entire surface. Close inspection of the early blight spots will usually show concentric lines. Early blight may occur alone or associated with late blight.

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*Papers from the Maine Agricultural Experiment Station: Entomology No. 64.

Though so common every year throughout the state, there are still many farmers who are quite unfamiliar with this flea-beetle. This is due to the fact that the insect is so small and active and feeds largely on the underside of the leaves.

HISTORY AND DISTRIBUTION.

In 1807 Illiger published a paper entitled "Portugiesische Käfer" in which he mentions the species *Haltica pubescens* as occurring in Coimbra and Lisbon (Portugal) stating further that he also had the species from North America (Pennsylvania). In 1835 Dr. T. W. Harris records the name *Haltica cucumeris* in his Catalogue of the Insects of Massachusetts. The same author published in 1841 his "Report on the Insects of Massachusetts Injurious to Vegetation" in which he says (p. 103):

"The most destructive species (i. e. of the *Halticini*) in this vicinity is that which attacks the cucumber plant as soon as the latter appears above the ground eating the seed-leaves, and thereby destroying the plant immediately. Supposing this to be an undescribed insect, I formerly named it *Haltica cucumeris*, the cucumber flea-beetle; but Mr. Say subsequently informed me that it was the *pubescens* of Illiger, so named because it is very slightly pubescent or downy." In a later edition Dr. Harris says "Count Dejean, who gave to it the specific name of *fuscula* considered it as distinct from the *pubescens* and it differs from the descriptions of the latter in the color of its thighs, and in never having the tips and shoulders of the wing-covers yellowish; so that it may still bear the name given to it in my catalogue. It is only one sixteenth of an inch long, of a black color, with clay-yellow antennae and legs, except the hindmost thighs, which are brown. The upper side of the body is covered with punctures, which are arranged in rows on the wing-cases; and there is a deep transverse furrow across the hinder part of the thorax."

Subsequent investigations have shown that the species described by Dr. Harris is distinct from *pubescens* and may therefore rightfully bear the name *cucumeris*. The specimens from Pennsylvania mentioned by Illiger were *cucumeris* and therefore differed from those collected in Portugal. The synonymy now stands as follows:

Epitrix cucumeris Harris. In Catalogue of Insects of Mass., 1835; Rept. on the Insects of Mass., 1841; Journal of Agriculture, I, 103, 1851.

E. fuscula Dejean, Cat'l. 3 ed. 415.

E. nigritula Dejean, olim.

E. pubescens, in part, Illiger's Mag. VI. 58, 1807.

E. seminulum Le Conte. Proc. Ac. Phil. 358. 1861.

Though the adult insect has long been known to entomologists it is only within the last few years that we have learned that the larvae live in the ground feeding on the roots and tubers of the potato and perhaps on related plants. It is true that both Fitch and Riley stated more than 40 years ago that the larva is a leaf miner but it seems that their statements are based upon inference rather than upon actual observations.

Fitch in his Eleventh Report (page 62) says in his discussion of the potato flea-beetle "Having given a full account of the larvae and transformations of this genus in connection with the striped flea-beetle (*Haltica striolata*), it is unnecessary to repeat the same details here." The larva of the striped flea-beetle mines in the leaves of turnips, beets and other plants of the garden according to Fitch's account, and from his statement in the preceding sentence we are led to infer that the larva of *Epitrix cucumeris* also is a leaf miner. There is however nothing in his account in which he states that he actually found the larvae of the potato flea-beetle and we must therefore assume that it was merely a guess on his part.

Riley in his First Annual Report as State Entomologist of Missouri (p. 101, 1869) writes:

"..... The larva feeds internally upon the substance of the leaf, like that of the closely-allied European Flea-beetle of the turnip (*Haltica nemorum*); and, from its near relationship to that insect, we may infer that it goes underground to assume the pupa state, that it passes through all its stages in about a month, and that there are two or three broods of them in the course of the same season."

Though it is definitely stated here that the larva mines in the leaves there is nothing so far as I have been able to discover in Riley's writings showing that this is based on personal observations. A number of entomologists since then have made similar statements but all of their accounts bear evidence of having been copied from the writings of the earlier authors.

Another error, apparently also inherited from the earlier writers, frequently found in the published accounts of these beetles, is the unqualified statement that there are 2 or 3 generations a year. In Maine there is but one generation or at

most only a partial second. Mr. F. A. Sirrine's observations made in 1896 in New York are confirmed by our own. He says "As the facts stand there is probably but one brood of the potato flea-beetle a year."

Distribution. The potato flea-beetle has a wide distribution in this country, having been recorded from most of the states from Maine to California. The species is mentioned in the publications of over half of the Agricultural Experiment Stations.

HABITS AND DESCRIPTION.

The hibernating adult beetles emerge from their hiding places under leaves and rubbish during April and May, in this State usually the latter month, and may be found upon plantain, and other weeds, as well as upon the foliage of wild cherry, apple, maple and other trees, where they apparently feed but little if at all at this time for the leaves upon which they are found resting do not bear evidence of feeding punctures. A little later when the young tomato plants are set out, early in June in the vicinity of Orono, the flea-beetles feed upon them, frequently in such numbers as greatly to impair the growth of the plant. From the middle to the last week in June mating pairs are seen. The first eggs the past season at Orono were found on June 26, and none found later than the middle of July. The eggs which were obtained from adults, confined under cheese cloth covered lantern globes set over earth filled flower pots, are laid singly in the ground. The egg (fig. 10) is white in color, elongate ellipsoid in shape, its long diameter about 2 1-2 times the shorter, about .25 mm. long, the surface feebly sculptured. Some potato plants growing in flower pots in breeding cages were "charged" with flea-beetles on July 3. On July 30 full grown larvae and a few pupae were found among the roots of these plants, the larvae mining in the seed potato, the body over half buried within the tuber, the posterior end sticking out at right angles to the surface. The pupae as well as some of the larvae were found free in the earth among the roots.

The larvae (fig. 11) are white, slender, wormlike creatures with distinct dark brown head and yellowish-brown thoracic shield. The head is oval; the mandible subtriangular, the apex with about 4 blunt teeth of which the laterals are smallest (fig.

10, a); the antenna is short, less than half as long as the mandible, subcylindrical, about twice as long as wide; the palpus is stout at base, apical joint conical, nearly as long as the antenna; eyes apparently wanting; setae of head distinct, but few in number. Thorax white, first segment with yellowish brown chitinized dorsal shield, setose. The legs are short, stout, setae few, tarsal claw simple, empodium distinct. Abdomen white, 9 segmented, each segment provided with about 24 setae, the spiracle distinct; ninth segment with rounded apex, unarmed except for the setae. Length about 5 mm.

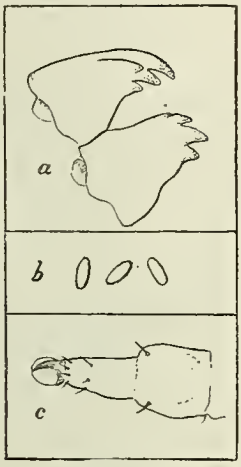

Fig. 10.

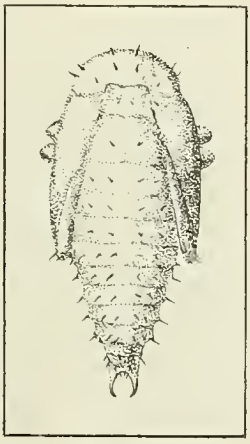

Fig. 12.

The pupa (fig. 12) is white, becoming darker when it is ready to transform. A transverse line of several setae is found on each abdominal segment, those on the lateral line longest. Apex of abdomen bifurcate; the forks slender, incurved and sharp. Length 2.2 mm.

During August 1912 larvae and pupae were to be found in the ground among the young tubers but by the end of the first week in September they had all disappeared. About the middle of July the beetles of this generation begin to emerge in Maine, becoming very abundant upon the potato vines and reaching a maximum about the first of September. The first killing frost in September marks the disappearance of the beetles to their places of hibernation. Our own observations are confirmed by those of Sirrine who says that the beetles emerge about July 10 in New York, and by those of Jones who gives July 20 as the date in Vermont.

From the dates given above it will be seen that six or seven weeks must elapse from the time of mating to the maturity of the adults of the next generation so that in this region at least, where we may expect killing frosts about the middle of September, there is time for but one complete generation per year.

Fig. 11. Larva.

The fact that neither larvae nor pupae were to be found among the roots or tubers after the first week in September, though abundant enough in the same field in similar situations in August, further substantiates this view.

Although in this state, as far as we have been able to ascertain, it is only the adult, which, by its leaf feeding habits, has proved injurious, in New York Messrs. F. A. Sirrine and F. C. Stewart have shown that the larvae are also responsible for seed potato in the ground.

Fig. 13. *Epitrix cucumeris:* adult flea-beetle much enlarged. (From Bulletin U. S. Div. Entomology No. 19.

In New York, the little larvae have been found boring into the tubers, roots, and root stalks of the potato. The wound made by the boring of the grub results in the formation of the some injury to potatoes, namely in causing, what has been termed "pimply" potatoes. So far as our own observations went the past season, the larvae fed only on the fragments of

"sliver", but a "pimple" may or may not be produced. In 1894 this trouble was sufficiently common in Eastern Long Island to attract the attention of the farmers. The following year buyers were on the lookout for potatoes thus affected and offered a reduced price for them.

The adult beetle (Fig. 13) is a small insect about one-twelfth of an inch in length with black body and dull yellow legs, and antennae. Its hind legs (Fig 17) are particularly stout and adapted for jumping, hence the name "flea-beetle." It is often called the cucumber flea-beetle because it was originally described as feeding on the cucumber; but this name is rather a misnomer, as the insect feeds by preference upon plants of the family Solanaceae which includes the potato and the tomato.

The genus *Epitrix* to which this insect belongs may be distinguished from its nearest allies by the following characters; very small convex species, bearing on its upper surface short, semierect hairs, sparsely placed over the thorax and arranged in a single row on each interval of the wing covers. The head has an oblique ridge each side extending from the end of the frontal carina to the eye and limited above by an impressed line, the two forming together a broad V. The front angles of the thorax are obliquely truncate with a small tooth behind the truncation. Several species are known from the United States of which three may occur in Maine. The species under consideration differs from its nearest relatives in having the thorax finely but not densely punctate, (Fig. 14) the punctures well separated, the ante basal impression well marked; the striae of the wing covers, especially those nearest the suture, very feeble, the punctures round, not crowded, the upper surface of the body shining piceous. The antennae and legs are reddish yellow, only the femora are darker, somewhat oblong. The thorax is nearly twice as wide as long, slightly wider at the base than the thorax, the umbone rather prominent. Length 1.5 to 2 millimeters (1-16 to 1-12 inch).

HOST PLANTS.

This insect feeds by preference on the members of the *Solanaceae* or Nightshade family embracing the potato (*Solanum tuberosum*), the wonder berry (*S. nigrum var.*), bittersweet or blue bind weed (*S. Dulcamara*) Jerusalem cherry,

(*S. Pseudo-Capsicum*), horse nettle (*S. carolinense*), black or common night shade (*S. nigrum*) egg plant (*S. melongena*) tomato (*Lycopersicum esculentum*), Cayenne pepper (Capsicum annuum), ground cherry or husk tomato (*Physalis pubescens*), Petunia (*Petunia nyctaginiflora*), tobacco (*Nicotiana tabacum*), and Jimson or Jamestown weed (*Datura Stramonium.*) Of these the beetle seems to prefer above all others the leaves of the wonder berry.

It has also been recorded as feeding upon leaves of the cucumber, squash, watermelon, muskmelon, bean, corn, radish, turnip, cabbage, sunflower, plantain, beet, spinach, celery, raspberry, apple, sweet potato, rhubarb, and hop.

In order to test the susceptibility of various plants other than those of the nightshade and gourd families to the attack of this insect, a number of flea-beetles, were placed in glass jars, with some leaves, each jar containing but a single species of plant. The beetles were collected at random from a potato field and all subjected to the same conditions. It was found that the leaves of the bean, sunflower, lettuce and the basswood were eaten with evident relish, and that the leaves of Oswega tea, wood sorrel, bluets, hemp nettle, celery, beet and plantain were slightly attacked. In our tests the insects refused to eat the foliage of raspberry, corn, turnip, cabbage, ground ivy, red clover, self heal, evening primrose, maple, dogwood, honey suckle, woodbine, (*Psedera*), twin flower, carrot, arbutus, vaccinium, viburnum, red elder, horse chestnut, dog bane, jewel weed, St. John's wort, wintergreen, violet, ilex, bedstraw, pipsissewa, partridge vine, sarsaparilla, phlox, ash, sumac, and shin leaf.

It will be noted that we were unable to induce the insects to eat the leaves of corn, turnip, cabbage and raspberry, upon which they had previously been recorded, while celery, beet and plantain were but very slightly attacked. It must be said however that in our experiments we used leaves that were full grown. Had new and tender leaves been placed in the jars the results might have been different.

CONTROL.

Parasites. In our own experiments with the flea-beetles we have found no parasites associated with them. In looking over the published accounts we find but two records in which parasites are mentioned.

Professor Forbes in the 21st report of the State Entomologist (p. 117) says "They are sometimes parasitized by a hymenopterous insect, probably one of the *Braconidae*." The other observation is by Dr. Chittenden in Bulletin 19, N. S. Division of Entomology, U. S. Department of Agriculture. He writes —"The flea beetle (i. e. *E. parzvula*) as well as *E. cucumeris*, is parasitized while in the adult condition by what is evidently, judging by the larvae, a species of the hymenopterous family Braconidae. Numbers of beetles were collected in order to rear the parasite. Larvae were first observed July 14, but none lived more than a few days after issuing from the beetles. All of the parasitic larvae, as far as could be learned, made their escape from an aperture made at the anal orifice of their host."

Tests of poisons. It has been frequently said that flea-beetles cannot be poisoned. While this of course is not true, it is well known that potato fields sprayed in the usual way for the Colorado potato beetle are not exempt from the attacks of the flea-beetle. Observation has shown that the flea-beetle feeds upon the unsprayed portion of the leaf and appears to avoid the poisoned part. If the upper surface of the leaf is wholly covered with the spray the beetle will feed on the underside, where indeed it usually feeds, by preference.* If some poison mixture could be devised that would prove attractive to the insect it would no doubt solve the problem of flea-beetle control. The successful use of sweetened poisoned bait for the combating the Grape Fidia (*Fidia viticida*) by the entomologists at the New York Experiment station at Geneva has suggested a trial of this method for the potato flea-beetle. The

*The peculiar feeding habit of the potato flea-beetle has been subject to field observation by Dr. W. J. Morse for eight or ten years both in Vermont and Maine and we can do no better than quote him in this particular:—"The flea-beetles, though they may be present in large numbers and doing much damage, are seldom seen by the potato growers. One reason, of course, is that they are so small. A more important one is that they are almost always found on the *under* sides of the leaves and eat from the under sides, never clear through the leaf, stopping just short of the upper surface. They eat so nearly through that the tissues above dry away leaving a small hole entirely through the leaf. It is certain that bordeaux mixture would be much more effective as a repellant to flea-beetles if it could be applied to the under side of the leaves."

following experiments were made during the summer of 1912 at Orono.

A small field was planted with potatoes and divided into five plots; one of which was sprayed with Bordeaux to which was added three pounds of arsenate of lead per 50 gallons of spray mixture; the second like the first but with the addition of 2 1-2 quarts of Karo corn syrup per 50 gallons of the spray, the third without bordeaux but using three pounds of arsenate of lead in 50 gallons of water; the fourth as in the third with the addition of 2 1-2 quarts of syrup; the fifth, unsprayed. The potatoes were sprayed at intervals of about two weeks during the season, and put on at the rate of 250 gallons per acre. The conditions under which these experiments were conducted rendered it impossible for us to keep a quantitative record of flea-beetle injury (counts of flea-beetle punctures) but in general it may be said that there was decidedly more flea-beetle injury in in the unsprayed plot than in the sprayed and least injury in the first and second plots which were sprayed with a mixture containing bordeaux. There was no noticeable difference between the plots which were sprayed with the mixture containing the syrup and the corresponding one without it. Had a pure corn syrup been used instead of Karo corn the result might have been different. The difference between the sprayed and the unsprayed plots was much more noticeable during September than earlier in the season.

Some laboratory experiments were also made. A number of beetles were placed in a glass jar with some tender potato leaves thoroughly drenched in an arsenate of lead spray mixture (three pounds in 50 gallons.)

In a second jar Watson's soluble arsenoid (an efficient poison for potato beetles) was used; in the third as in the first but with the addition of Karo corn syrup (2 1-2 quarts per 50 gallons). At the end of 24 hours all the beetles were still alive in the first and second jars, but over 2-3 were dead in the third. All the leaves showed feeding puncture at the conclusion of the test. Though we are scarcely justified from so limited a series of experiments in assuming that the syrup would be serviceable when used on a large scale, nevertheless, the results are interesting and suggestive.

Remedies. The foregoing experiments with Bordeaux mixture have only again demonstrated what has long been known that this fungicide is an excellent flea-beetle repellant. As it is not a poison but a repellant the key note to success in its use lies in thoroughness and frequency of spraying. Professor R. L. Jones formerly of the Vermont Experiment Station was the first to test this remedy and to demonstrate its efficiency.

Although flea-beetles are sometimes abundant in fields which are fairly well sprayed it must be borne in mind that the spray rarely covers the whole leaf and that the beetles attack the unsprayed part. There is, however, another factor which enters and that is that the beetles are much inclined to feed on the underside of the leaf frequently stopping just short of the upper surface. The tissue above dries away and this leaves a small hole through the leaf. As the spray for the most part strikes only the upper surface its effectiveness as a repellant is thus largely nullified. It is certain that bordeaux mixture would be much more effective if it could be applied to the under surface of the leaves. A spraying apparatus so devised that a portion of the spray could be directed upwards against the underside of the leaves would do much towards lessening the damage wrought by flea-beetles and thus also diminish the injury caused by early blight. Director Chas. D. Woods, of this station in a letter published Oct. 19, 1912, upon the subject of "Early Blight and Flea beetles" closes with these words, "One of the projects of the Maine Agricultural Experiment Station for the coming year is the construction of a more efficient potato sprayer and one with the nozzles so arranged, if possible, that they will meet the necessary requirements in the manner of the application of the spray to control early blight and flea-beetles. This may mean, to secure sufficient pressure and volume of spray, the construction of some sort of a gasoline power sprayer for potatoes."

From what has already been said it will be noted that the most effective remedy yet known against flea-beetles is the use of bordeaux mixture. It must be sprayed on so that the vines are well coated, and repeated at frequent intervals, at the rate of 100 or more gallons per acre. If other insects are also present, two pounds of lead arsenate to 50 gallons of the bordeaux, may be added.

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LIST OF INSECTS RECORDED ON POTATO.

EDITH M. PATCH.

This list was compiled from various sources as a part of the General Insect Catalogue used at the Maine Agricultural Experiment Station and the fact that it has proven useful in manuscript is the only excuse offered for its publication. It is a working list and doubtless incomplete. Additions or corrections from anyone kind enough to make them would be appreciated. The references are to accounts where the potato is recorded as a food plant.

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Epicauta maculata, Spotted Blister Beetle. Chittenden—Div. Ent. U. S. Dept. Agr. Bul. 43, p. 24, 1903.

Epicauta marginata, Margined Blister Beetle. Chittenden—Div. Ent. U. S. Dept. Agr. Bul. 43, p. 24, 1903.

Epicauta pennsylvania, Black Blister Beetle. Chittenden—Div. Ent. U. S. Dept. Agr. Bul. 43, p. 25, 1903.

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Ligyrus gibbosus, Carrot Beetle. Chittenden—Div. Ent. U. S. Dept. Agr. Bul. 43, p. 26, 1903.

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Trichocera vegetationis. Johannsen—Bul. 177 Me. Agr. Exp. Sta., p. 34, 1910.

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Halticus uhleri, Carden Flea Hopper. Britton—4th Rep. St. Ent. Conn. for 1904, p. 217, 1905.

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Pentatoma (Lioderma) uhleri, Western Green Stink-bug. Forbes—Bul. 60, Univ. Ill. Agr. Exp. Sta., p. 445, 1900.
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Empoasca mali. Osborn—Bul. 108, Bu. Ent. U. S. Dept. Agr. p. 100, 1912.
Empoasca viridescens. Bul. 18, Bu. Ent. U. S. Dept. Agr., p. 101, 1898.
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Icerya purchasi, Cottony Cushion-Scale. Riley—Report of Ent. for 1886 in Rep. U. S. Comm. Agr., p. 474, 1887.
Ormenis (Poecilopteta) pruinosa. Mealy Flata, Frosted Lightning. Hopper. Chittenden—Bu. Ent. U. S. Dept. Agr. Bul. 22, p. 98, 1900.
Orthezia insignis. Lounsbury—Bul. 28, Hatch Exp. Sta., p. 26, 1895.
Paratrioza cockerelli, Tomato Psyllid. Johnson—News Notes Col. Agr. Col.
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Gryllus sp. Riley—Insect Life. Vol. 1, p. 87, 1888.
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Melanoplus (Caloptenus) spretus, Rocky Mountain Locust, Riley-Packard-Thomas—1st Ann. Rep. U. S. Ent. Com. 1877 (1878), p. 251.
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Stenopelmatus.. Clarke—Univ. Cal. Agr. Exp. Sta. Bul. 135, p. 29, 1901.

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Euthrips tritici, Wheat Thrips. Hinds—Proc. U. S. Nat. Mus. Vol. 26. p. 148.

Collembola.

Lipura fimetaria. Lintner—N. Y. St. Ent. Rep. II, p. 209. 1885.

Acarina.

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Myriopoda.

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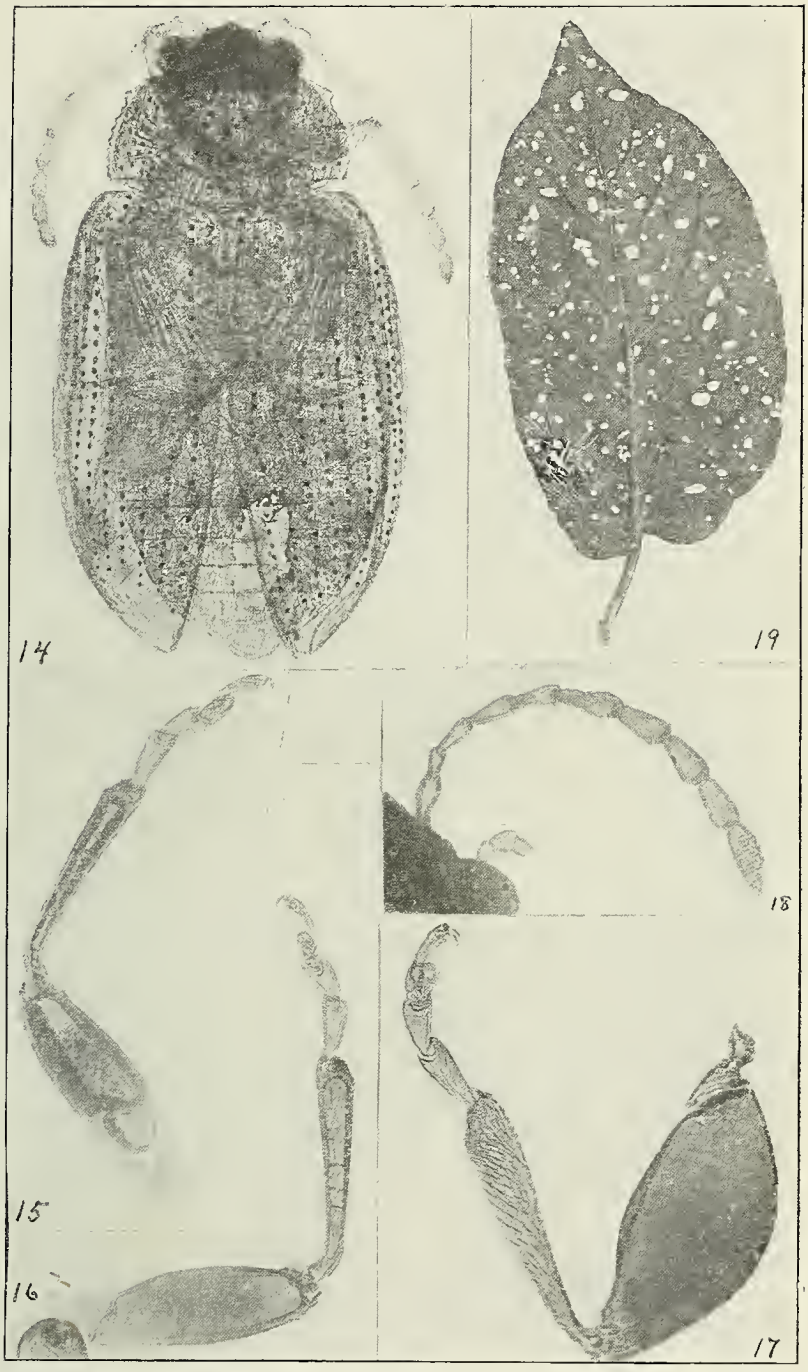

Fig. 14. Potato Flea-beetle, showing punctures. Enlarged. Figs. 15 and 16. Fore and middle legs. Fig. 17. Hind leg. Fig 18. Portion of head showing antenna. Fig. 19. Potato leaf riddled by flea-beetles.